United States
Environmental Protection
Agency

Atmospheric Research and
Exposure Assessment Laboratory
Research Triangle Park, NC 27711

Research and Development

EPA/600/SR-92/152 October 1992

EPA

Project Summary

Summary Report for the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) Site Visitation Program for the Period October 1988 through September 1989

W.C. Eaton, C.E. Moore, R.W. Murdoch, R.C. Shores, D.A. Ward, C.O. Whitaker, and R.L. Lampe

The proper collection of precipitation and the accurate measurement of its constituents are important steps in attaining a better understanding of the distribution and effects of "acid rain" in the United States. One of the major programs of the National Acid Precipitation Assessment Program (NAPAP) Task Group IV concerns wet deposition monitoring. One of that program's projects, 4A-15, "Quality Assurance Support for Wet Deposition Monitoring," is sponsored by the U.S. Environmental Protection Agency (EPA) to evaluate the sample collection process and provide technical assistance to the NADP/NTN network through a site visitation program. Research Triangle Institute, as contractor to EPA, conducts these visits. If deficiencies or nonstandard procedures are noted, the site operator and supervisor are notified. Brief reports are sent to the EPA Project Officer, the NADP/NTN Quality Assurance Manager, and others. In this way, necessary changes can be made promptly.

All NADP/NTN sites were visited in 1985–1986. A second round of visits began in October 1986, with the goal of visiting approximately one-third of the 200 sites each year over the next three years. This document is a summary report of the findings from the 1988–1989 (Fiscal Year 1989) site visitation program to 72 of the sites of the NADP/NTN network. In its present configuration, the network's research and monitoring programs are supported and operated by the U.S. Geological Survey; State Agricultural Experiment Stations; the Departments of Agriculture, the Interior, Commerce, and Energy; and EPA. Additional support is provided by state agencies, public utilities, and industries.

Protocols and procedures followed in conducting the site visits are described. Results of systems and performance audits are discussed for siting, collection equipment, and the field support laboratories. Where exceptions are found, the potential effects of nonstandard siting, improperly operating equipment, and improper sample handling or analysis technique on the database are discussed.

This report was submitted in partial fulfillment of EPA Contract No. 68-D8-0001 by Research Triangle Institute. This report covers site visits made during the period October 1, 1988, through September 30, 1989. All work was completed as of September 30, 1989.

This Project Summary was developed by EPA's Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC, to announce

key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The main report summarizes quality assurance assistance and findings from site visits made to the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) precipitation collection stations for the period October 1988 through September 1989. Each site is located and operated according to protocols and procedures as given in the siting and operating manuals for the networks. The purposes of the site visitation program, sponsored by the U.S. Environmental Protection Agency (EPA), are to verify that each site is operating within control limits and according to established procedures, and to provide technical assistance as required.

Seventy-two of the 199 sites (with duplicate sites bringing the total to 208) that were in operation during 1989 were visited during this timeframe. Figure 1 shows the NADP/NTN site locations.

Goals of the Site Visitation Program

The goals of the site visitation program for quality assurance assistance to the NADP/NTN collection sites are as follows:

1. Provide a qualitative assessment of each site and its surroundings, the operator's adherence to sample collection and analysis procedures, and the condition of the site's collection and analysis equipment through an on-site systems survey;
2. Provide a quantitative assessment of the operation of the precipitation collector and the accuracy of response of field and laboratory measurement devices for precipitation depth, mass, temperature, conductivity, and pH through an on-site performance survey;
3. Provide technical assistance to the operator by verbal explanation, minor troubleshooting, repair and calibration of equipment, and by making recommendations for sources of corrective action;
4. Prepare brief reports for each site detailing site characteristics, results of quality assurance tests, and technical assistance provided. Submit the reports to the NADP/NTN Quality Assurance Manager, the Central Analytical Laboratory's Site Liaison, and the EPA Project Officer;
5. Computerize results of information gathered from each site and submit this to the NADP/NTN Quality Assurance Manager on an annual basis;
6. Document the sites and their surroundings by assembling a collection of site maps and color photographs.

Conclusions

Seventy-two of the 199 active NADP/NTN precipitation collection sites were visited over the one-year period, October 1988 through September 1989. About one-third of the sites were visited during this third year of a four-year effort. The sites are located in all regions of the country and are sponsored and operated by numerous agencies. Each site is located ac-

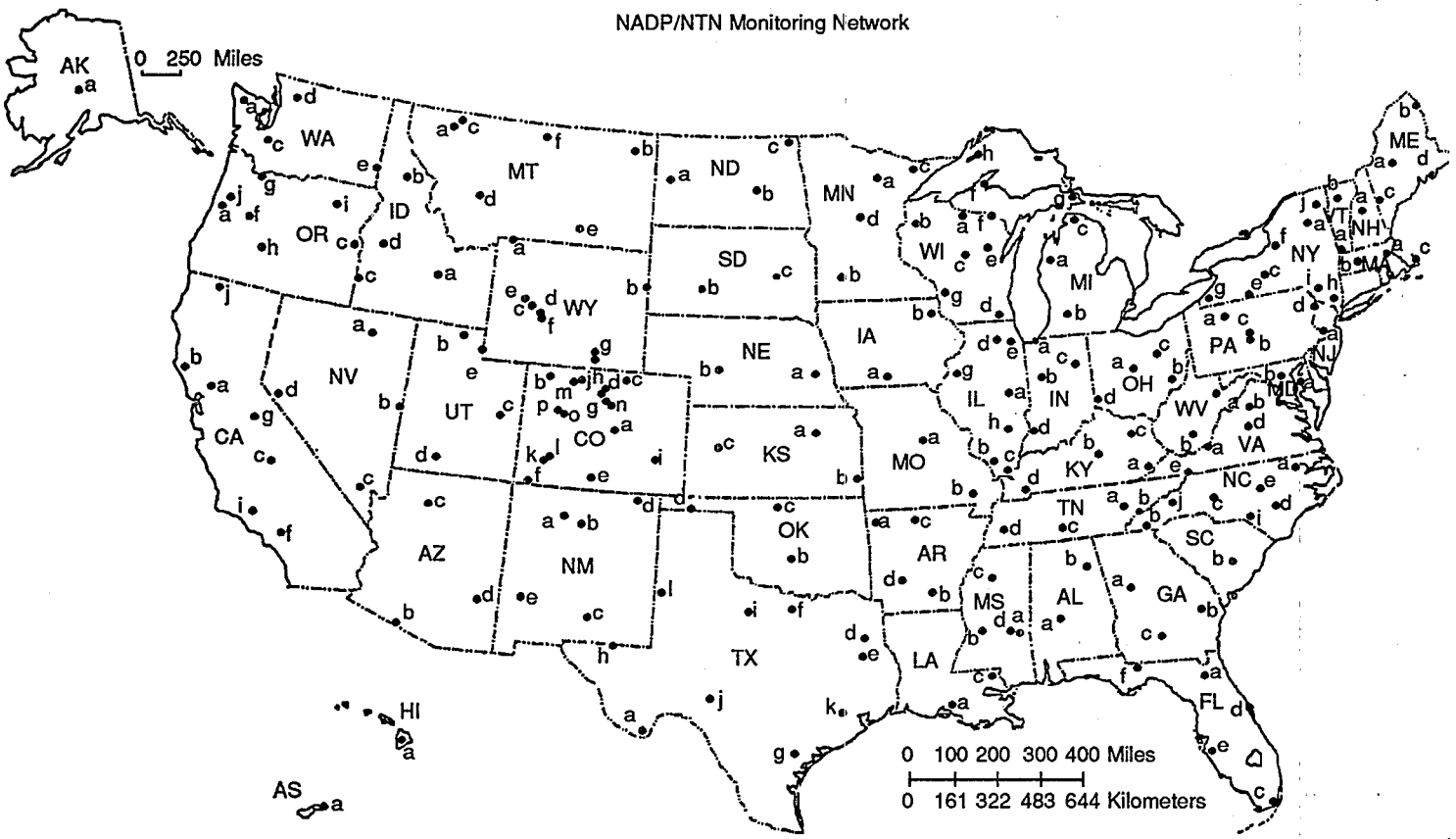


Figure 1. Active sites in the NADP/NTN monitoring network during 1989.

cording to established siting criteria and operates according to published procedures. This report assesses the degree to which criteria and procedures are adhered; predicts, where possible, the relative impact on the data that might be expected from the variances found; and compares results from the first round of visits to those documented in the first round of visits that occurred over the period December 1984 through September 1986.

Siting

Improvements in adherence to siting criteria were noted at most of the sites visited in 1989 that were not in compliance at the time of the first round of visits in 1985–1986. A number of sites had separated the collector and rain gauge to the prescribed 5-m distance and had oriented the collector's wet-side bucket to the west. Obstructions and sources of dust such as animals, parking lots, and chemical storage areas had been removed, or the site's equipment had been moved away from them.

For the 13 siting criteria summarized in this report, 55 of 72 sites (76%) visited in FY 1989 had at least one variance. Twenty-one percent of the sites had three or more variances. However, most of the variances are expected to have minimal effects on the database because of the nature of certain criteria and/or the degree to which the criteria were exceeded. For example, network siting criteria require that the precipitation collector and rain gauge be separated by at least 5 m but not more than 30 m. Twenty-four percent of the 72 sites did not meet this criterion, always because of inadequate separation.

Sample Collection

Designated sample collection procedures were adhered to at almost all the sites in the network. All operators were careful not to touch the inside of the collection bucket or lid or contaminate the sample in any way. All but one of the site operators stated that they checked the sample for contaminants (leaves, bird droppings, etc.) at the time of the bucket's removal from the collector. This procedure was not being well adhered to at the time of the first round of visits.

To ensure accurate precipitation data, it is most important that the precipitation collector and rain gauge are properly working and well maintained. All sites were able to make a weekly equipment check. A properly working precipitation collector should uncover the wet bucket at the beginning of a precipitation event and recover the wet bucket shortly after the event stops to keep matter such as dust out of the wet bucket when there is no precipitation. There were indications at 17 of 72 sites (24% of the total) that the clutch on the Aerochem Metrics precipitation collector was wearing; however, only 3 of these 17 failed to operate properly when tested with a 1600-g load. Only 3 of 70 sensors checked were not operating properly. Forty-nine percent of the rain gauges (34 of 70) were found to be out of calibration by more than ±0.1 in. at some point on the 0–12-in. scale. This is not believed to be a major source of error because the calibration errors usually occurred at a depth of 5 in. or more, and the operator is instructed to empty the catch bucket before this depth is reached. Calibration checks showed that 59 of the 70 gauges (84%) met acceptable calibration criteria (±0.1 in.) over the range of 0 to 5 in.

Field Laboratory Procedures

Field laboratory procedures for sample handling, conductivity measurements, and pH determinations were being carried out properly and accurately in most cases. Proper procedures were discussed or demonstrated to site operators as needed.

Results were improved over those noted at the time of the first round of visits. For example, all 67 sites with operational pH meters were able to determine the pH to within ±0.1 unit of the designated value. Five sites had inoperative pH meters and could not be checked. All three of the sites that were outside of tolerance for pH measurements in Round 1 were within tolerance in Round 2. Overall, 100% of the 67 field laboratories checked in 1989 agreed within ±0.1 pH unit with the audit solution's designated value.

For conductivity measurements, 65 of the 67 sites checked (97%) determined the audit solution's conductivity to within ±4 µS/cm of the designated value. Four sites had exceeded the limit of agreement during Round 1 visits. Five sites had malfunctioning or broken equipment and thus could not be audited.

The solution balances were operating properly in all cases checked. Of 71 balances checked, more than half agreed within ±1 g with the designated weight over the range of 823 to 5116 g. All but one balance agreed within ±5 g with the designated weight over the same range. In terms of percent variation with respect to weight, the worst case for the 70 balances that operated with ±5 g agreement would be ±0.4% at a loading of 823 g and ±0.1% at a loading of 4943 g.

Recommendations

The site precipitation collector and rain gauge are central to the successful operation of the network. However, the equipment in the NADP/NTN network is aging and will require increased maintenance. Therefore, weekly equipment checks by the operator should continue to detect problems as early as possible. The collector's clutch assembly should be inspected for signs of wear. The failure rate of the precipitation collector's sensor heaters has greatly diminished. A simple check of the collector's sensor heater, by activating the collector with water and, after 5 min, lightly touching the sensor surface to verify it is heating, should continue.

A number of rain gauges were found to be out of calibration. However, many of those calibrated in 1985–1986 met specifications in 1989. It is recommended that a simple, on-site calibration check of the rain gauge be carried out every six months. A copy of the gauge chart used for the check should be forwarded to the network's Central Analytical Laboratory (CAL) for review.

Recommendations for improving site locations center on those siting criteria that, if violated, may affect the catch efficiency or chemistry of the precipitation samples. Specifically, it is recommended that the NADP/NTN Coordination Office take the following steps to correct conditions at several sites:

- Relocate the collector or remove the obstruction (tree, etc.) that causes the 45° angle rule to be violated (four sites).
- Relocate the collector or restrict use of nearby parking lots and storage facilities so that a 100-m separation is achieved (three sites).
- Relocate the collector or install fencing so that animals are kept at least 30 m away (12 sites).
- Relocate the collector so that transportation roadways and sources are at least 100 m away (six sites).
- Reorient the collectors whose wet-side collection bucket faces north or east so that all wet-side buckets face west (15 sites).
- Where expedient and inexpensive to do so, relocate collectors or rain gauges so that a minimum separation distance of 5 m is achieved (17 sites).
- Emphasize to site operators and supervisors that grass, weeds, and small trees or bushes should be kept at a height of 2 ft or less in a circle with a radius of 30 m from the collector (13 sites).

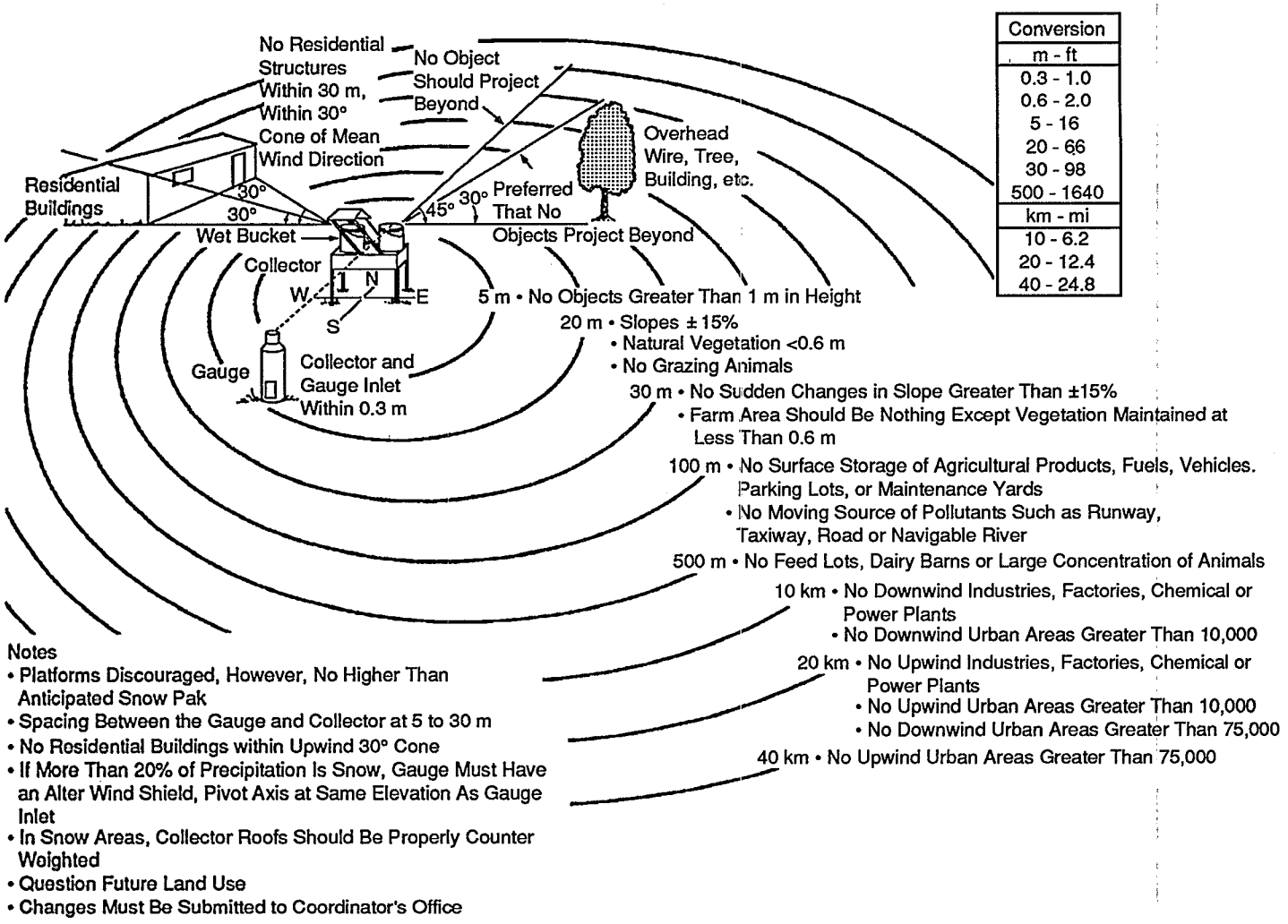
- Level any collectors or rain gauges that are out of tolerance (12 sites).
- Investigate whether or not the resistivity required to activate the collector sensor should be set closer to the factory value of 80K Ω for several of the collectors.
- Supply rain gauge damping fluid (silicone oil) to those sites that may need to fill reservoirs to within 0.25 in. of the top.

Site Survey Visits

A quality assurance systems survey was conducted at each site to qualitatively assess the site, its surroundings, and the operator's adherence to procedures specified in the NTN design document and in the NADP/NTN site operator's instruction manual. Criteria for siting an NADP/NTN precipitation station are illustrated in Figure 2. The operator was asked to demonstrate sample collection and analysis procedures. These were observed with special attention given to calibration procedures and sample handling technique. Site equipment was examined for signs of wear or faulty operation. It was noted whether solutions and equipment were properly stored. Site logbooks and rain gauge charts (if present) were examined for legibility, completeness, and accuracy.

Information from the systems survey was entered in the systems survey questionnaire. Two sets of photographs (color slides) of the sites were taken. The N, E, S, and W views were photographed with the precipitation collector in the foreground. Additional views were taken as specified in the questionnaire.

A quantitative performance survey was conducted at each site. Table 1 lists the equipment that was checked for performance and the type of test used. Criteria for evaluating performance are specified in the NADP Quality Assurance Plan.



Conversion	
m - ft	
0.3 - 1.0	
0.6 - 2.0	
5 - 16	
20 - 66	
30 - 98	
500 - 1640	
km - mi	
10 - 6.2	
20 - 12.4	
40 - 24.8	

Figure 2. NADP/NTN siting criteria.

Table 1. NAPD/NTN Measurements and Performance Survey Methods

Site Measurement	Measurement Device	Performance Suurvey Method	Designated Performance Criteria
Rain depth	Rain gauge (Belfort)	Challenge with known weights that simulate rainfall.	Agreement within ±0.1 in. of test weight value over the range 0–12 in.
Precipitation sample collection	Precipitation collector (Aerochem Metrics)	Measure resistance across sensor, measure tension and drop of bucket lid, measure temperature and resistance of activated sensor.	Resistance in range of 60–90K Ω. Lid drop distance >3 mm. Sensor temperature ambient prior to activation; temperature of 50–70°C after activation.
Mass	Triple beam balance	Challenge with traceable weights.	Agreement within ±5 g of test weight value.
pH	pH meter and electrode	Challenge with simulated precipitation sample of known pH.	Agreement within ±0.1 pH unit of test solution's designated value.
Conductivity	Conductivity meter and cell	Challenge with simulated precipitation sample of known conductivity.	Agreement within ±4 µS/cm of test solution's designated value.

*U.S. Government Printing Office: 1992 — 648-080/60114

W.C. Eaton, C.E. Moore, R.W. Murdoch, R.C. Shores, and D.A. Ward are with Research Triangle Institute, Research Triangle Park, NC 27709.
***Robert L. Lampe** is the EPA Project Officer (see below).*
The complete report entitled "Summary Report for the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) Site Visitation Program for the Period October 1988 through September 1989," (Order No. 92-219823; Cost: $26.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Atmospheric Research and Exposure Assessment Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

Official Business
Penalty for Private Use
$300

EPA/600/SR-92/152

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35